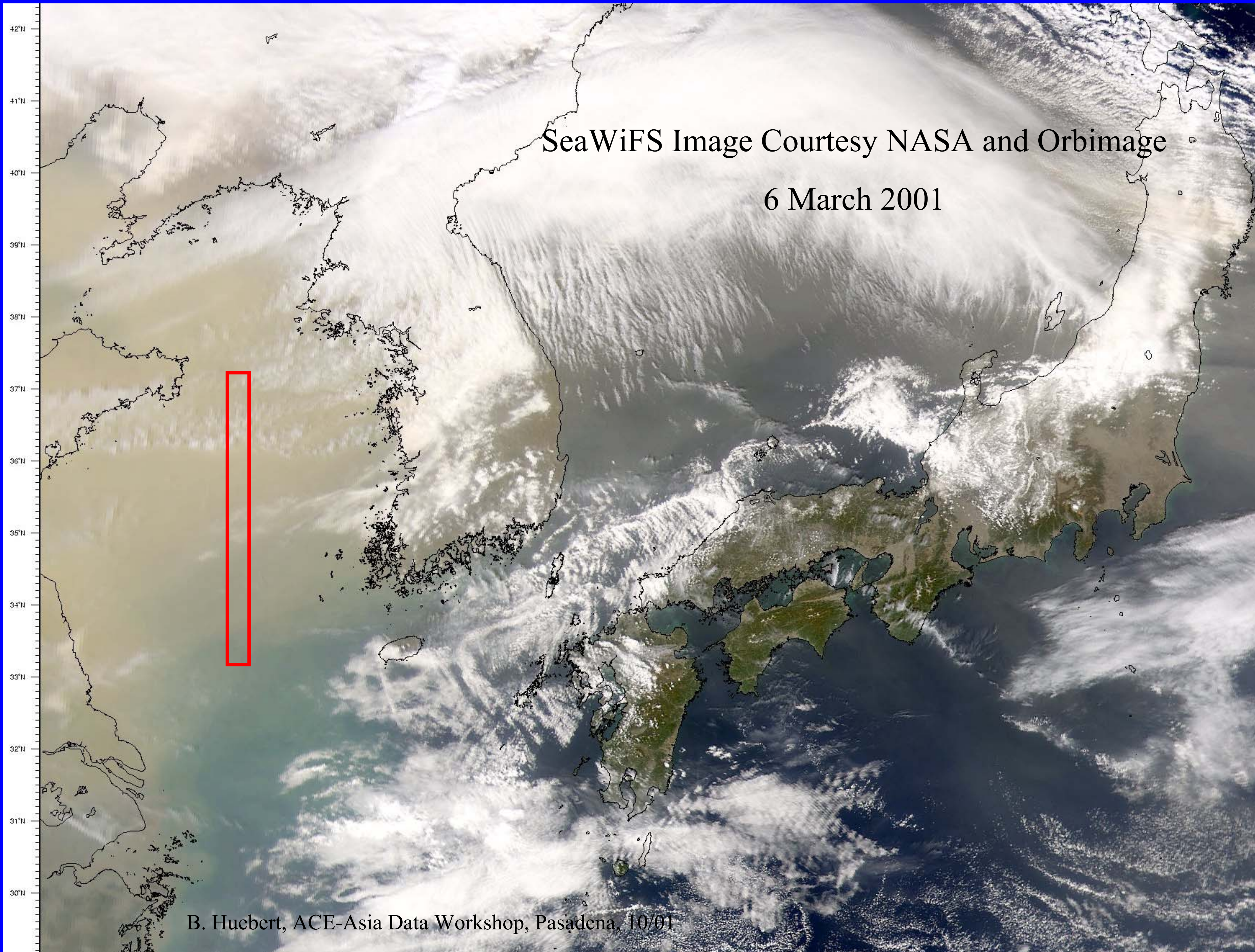
Outstanding Questions About Asian Aerosols

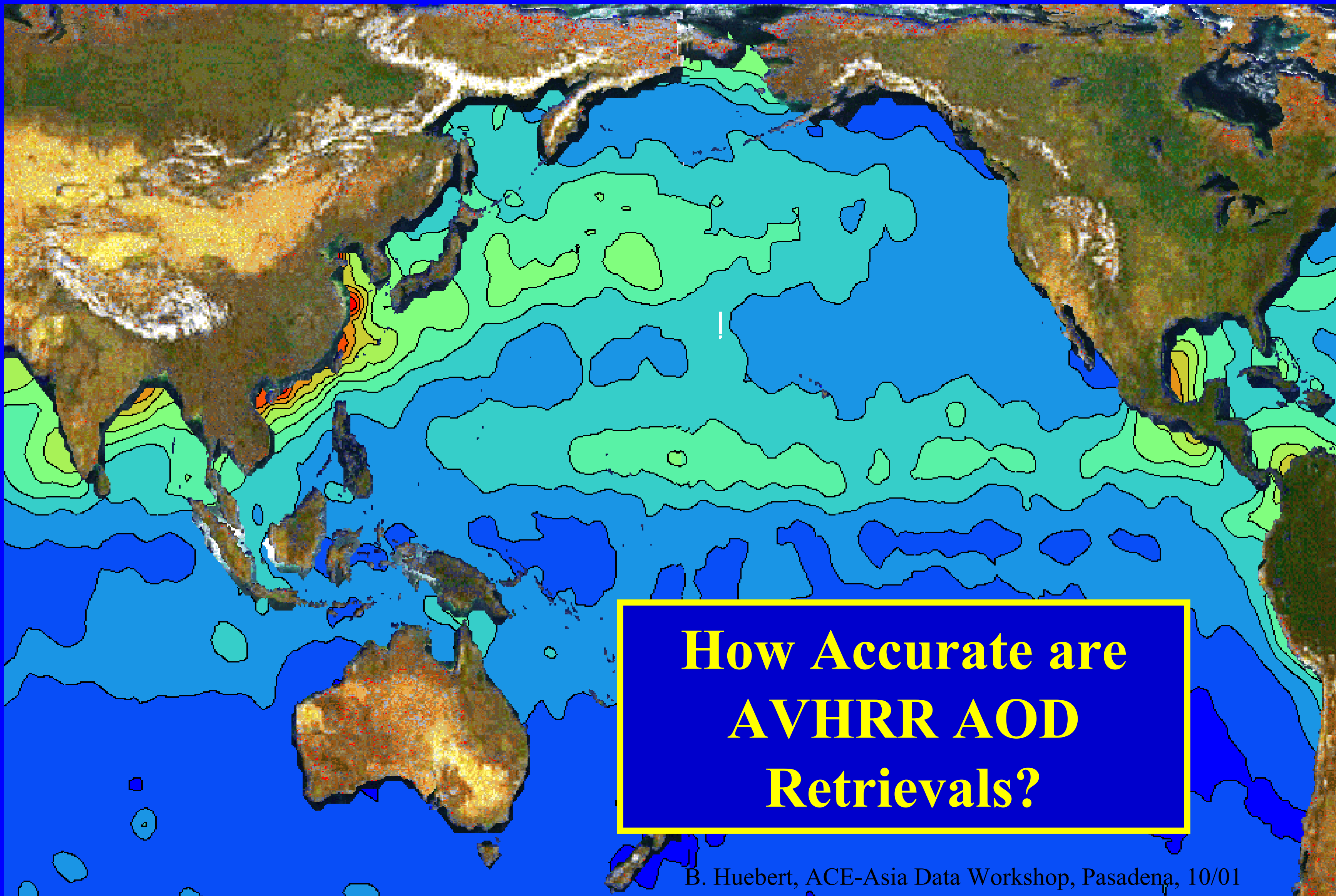
Approaching Japan from the Pacific in the C-130

B. Huebert, ACE-Asia Data Workshop, Pasadena, 10/01

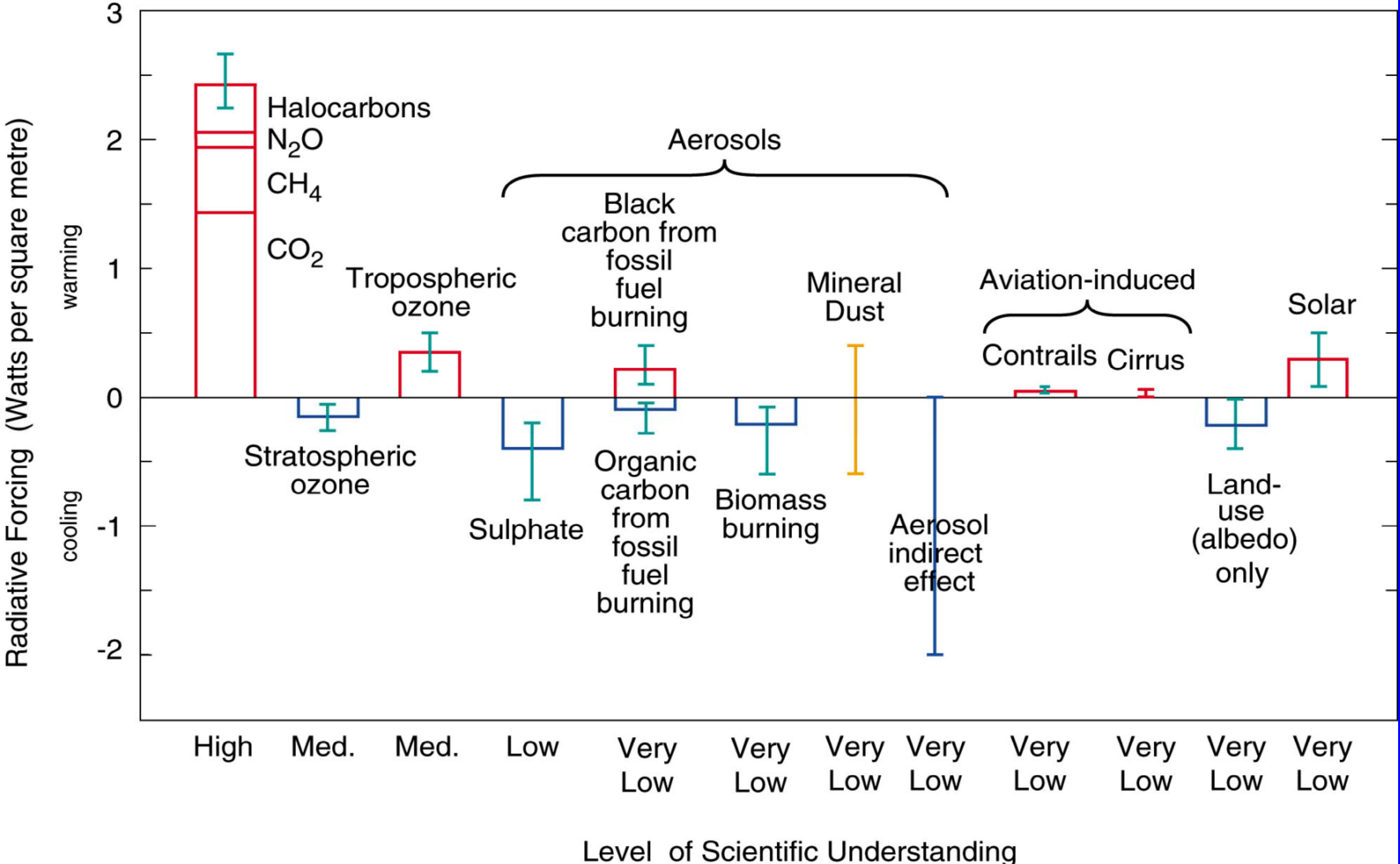

SeaWiFS Image Courtesy NASA and Orbimage
6 March 2001
B. Huebert, ACE-Asia Data Workshop, Pasadena, 10/01

Aerosol Optical Thickness Inferred from AVHRR Satellites

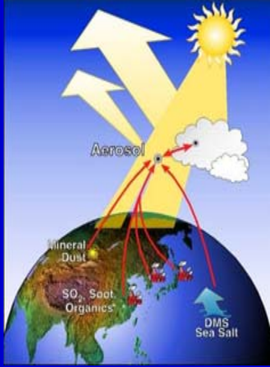
(March, April, May Average) - Stowe and Husar



The global mean radiative forcing of the climate system for the year 2000, relative to 1750



Source: IPCC Third Assessment Report



ACE-Asia Objectives:

- **Characterization:** **Determine the physical, chemical, and radiative properties of the major aerosol types in the Eastern Asia and Northwest Pacific region and investigate the relationships among these properties.**

- **Radiation:** **Quantify the interactions between aerosols and radiation in the Eastern Asia and Northwest Pacific region**

- **Processes:** **Quantify the physical and chemical processes controlling the evolution of the major aerosol types and in particular of their physical, chemical, and radiative properties.**

ACE-Asia Observation Sites

Aircraft and Ships Were Positioned Using Simulations From Three Chemical Transport Models Running in a Forecast Mode:

CFORS

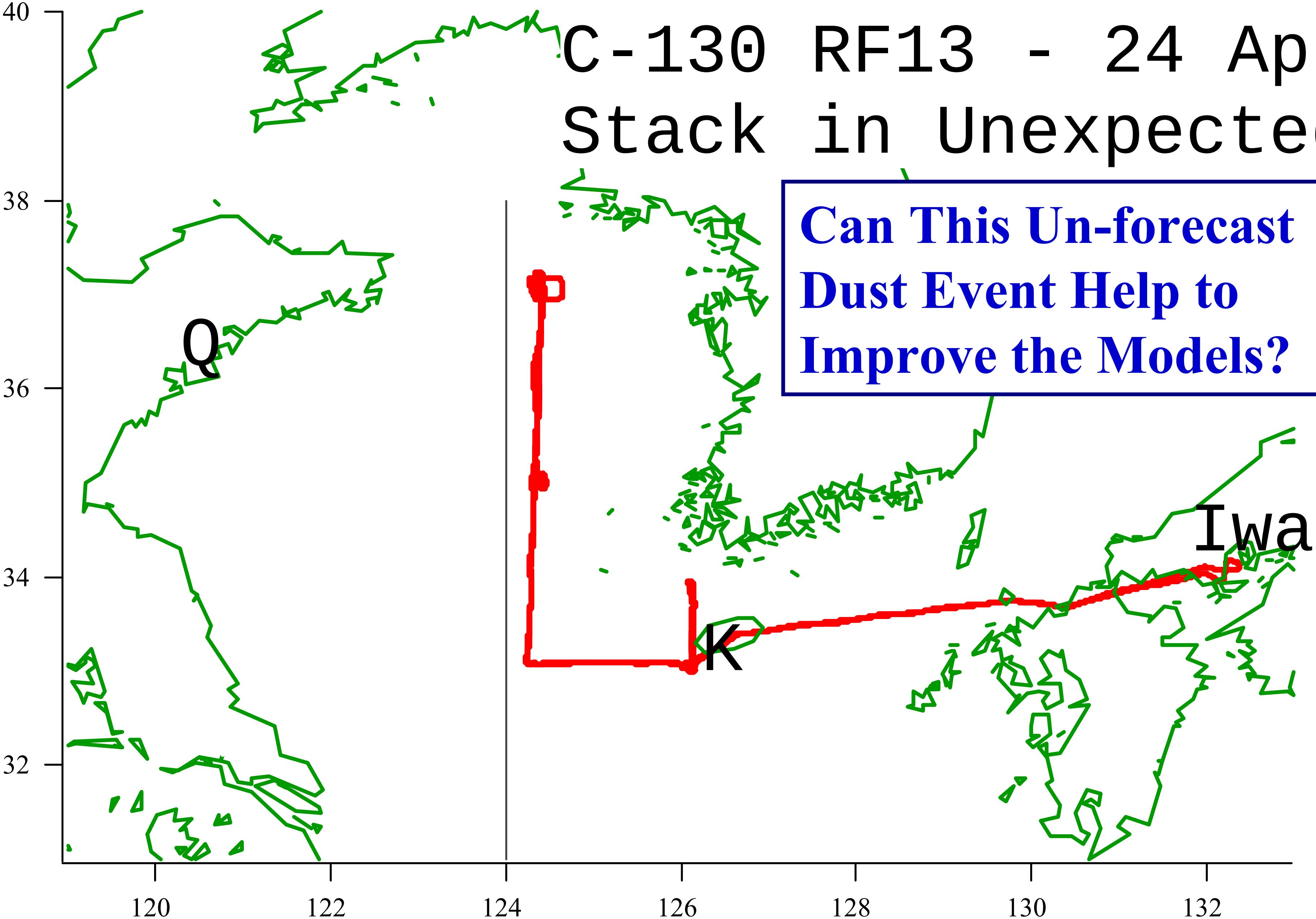
MATCH

GOCART

How well can we expect them to do with the complexity of layering and mixing of sources in Asian outflow?

C-130 RF13 - 24 Apr
Stack in Unexpected

Can This Un-forecast Dust Event Help to Improve the Models?



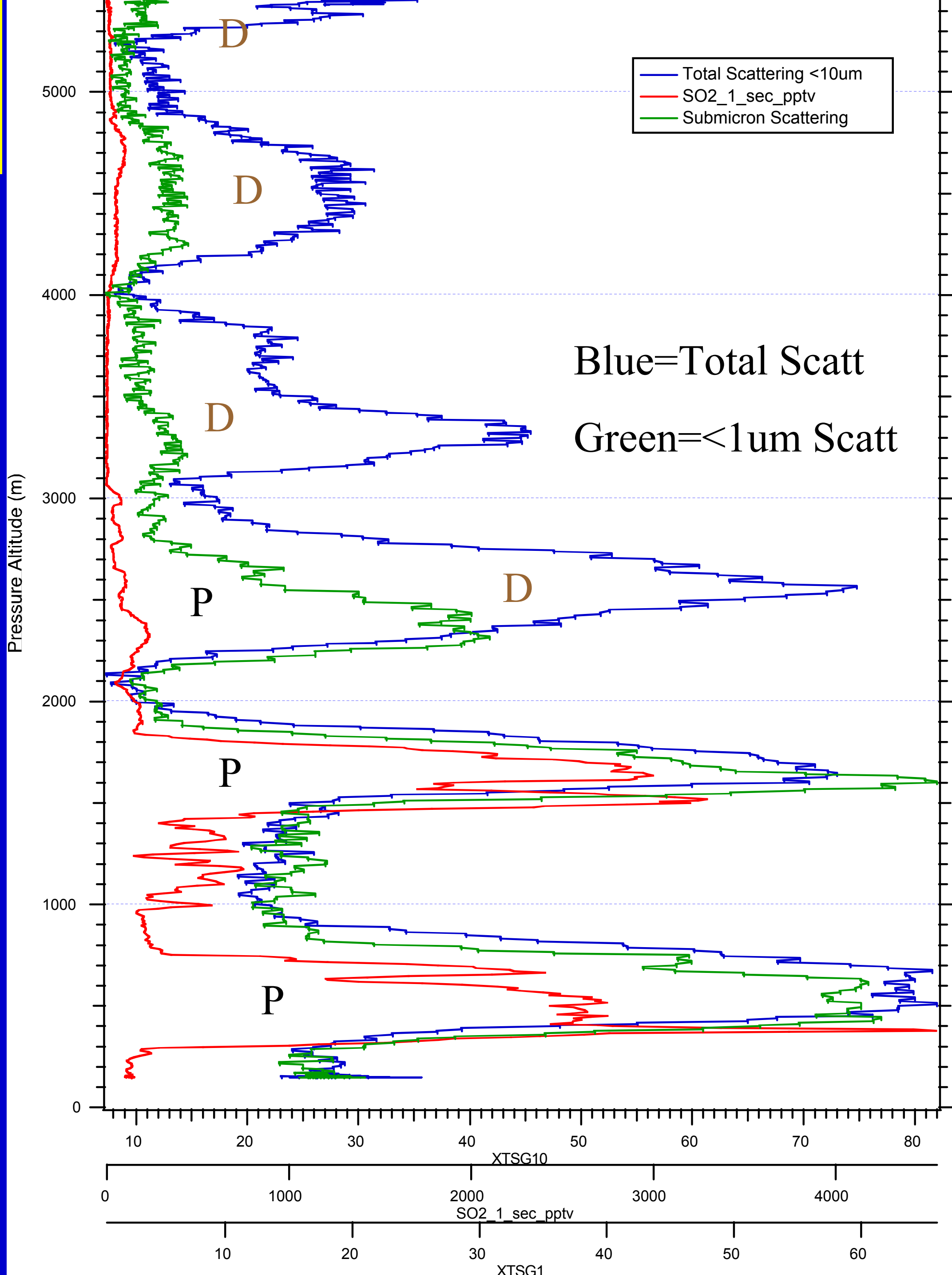
SO_2 and Scattering Profiles

The 1 sec time response of the APIMS enabled us to identify layers accurately. In this ascent profile the scattering (blue and green) lagged the SO2, raising the apparent layer height.

We often found SO2 maxima at cloud height!

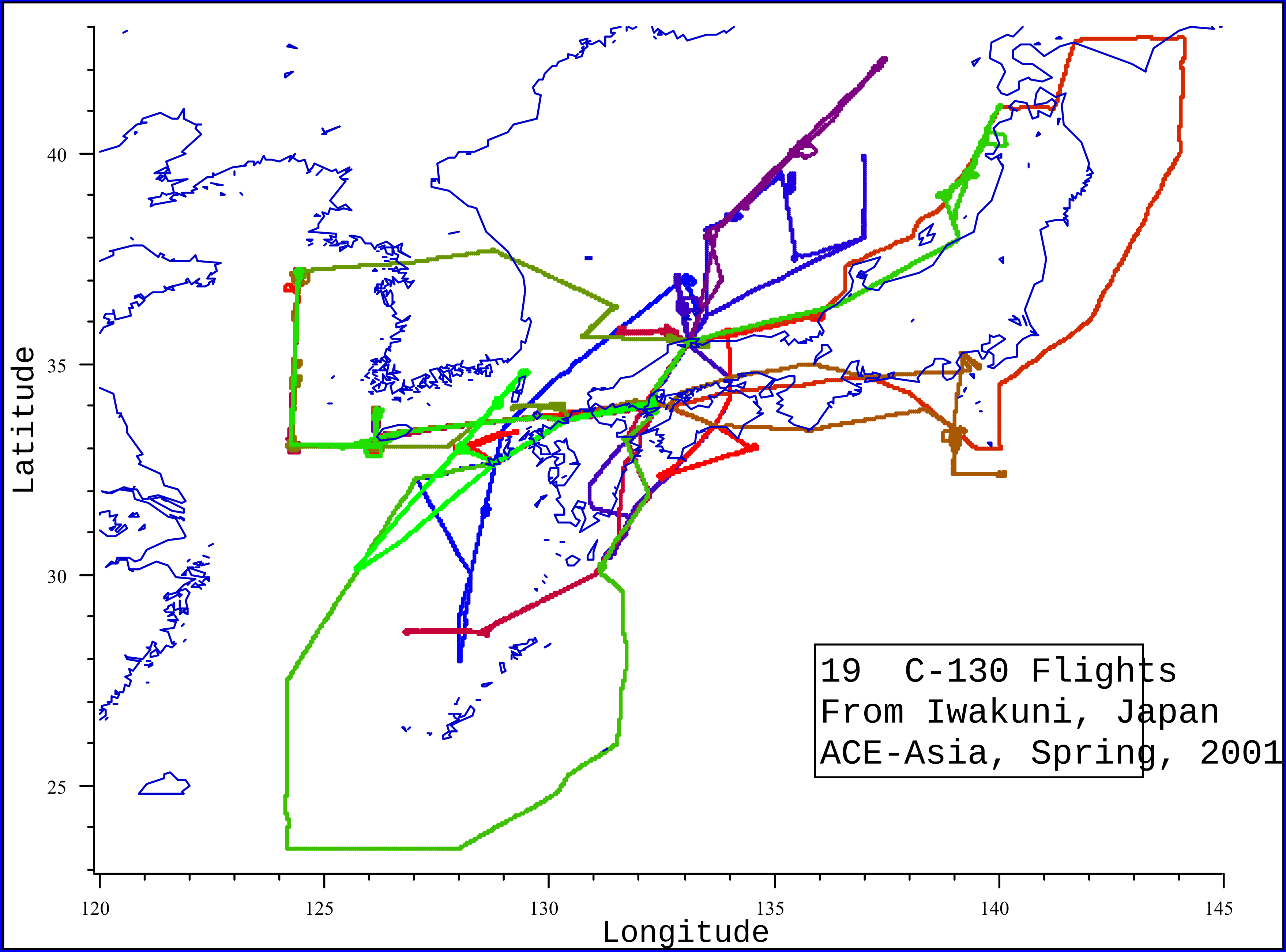
Byron Blomquist, UH

Alan Bandy, Drexel



The NCAR/NSF C-130 flew 19 research flights from Iwakuni, Japan

Photo by A. Clarke, UH, from NASA P-3


19 C-130 Flights
From Iwakuni, Japan
ACE-Asia, Spring, 2001
Latitude
Longitude
40
35
30
25
120
125
130
135
140
145

C-130 Accomplishments

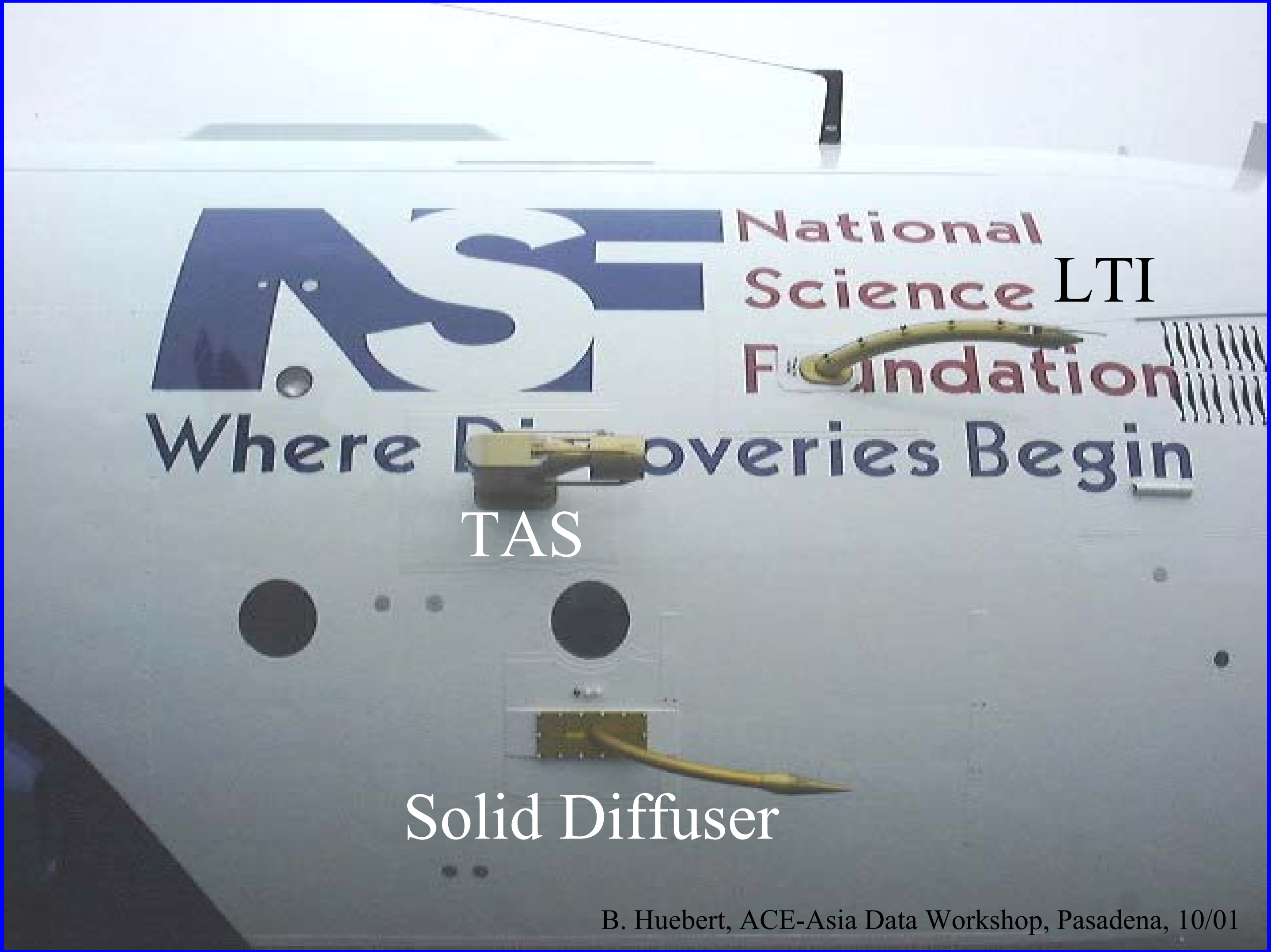
Objective	Flight Number																		
x = successful; o = attempted	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Radiation Profile/Column Closure	x	x	x		x		x	x	x	x		x	x	x		x	x	x	o
Satellite Intercomparison																			
MODIS	x	x	x	x			x	x				x			x			x	o
MISR		x	x					x		o		x		o	x			x	o
MISR Local Mode			x					x		o				o				x	
SeaWiFS							x	x		x		x		x	x	x			
NOAA-14								x						o	x				
NOAA-16							x	x				x			x				
Radiation Gradient					o		x	o	o	o							x		x
Aerosol Characterization																			
Dust	x				x	x	x	x		x	x		x		x				x
Urban/Industrial Plumes	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x			x
Biomass Burning					o		x												
OC/EC							x									x			x
Volcano											x								
Regional Aerosol Characterization																			
Cross-country upwind/downwind									o		x				x				
Long horizontal chemical gradient											x		x		x	x			
Urban plume vs distance	N	e	v	e	r		A	t	t	e	m	p	t	e	d				
Platform Intercomparisons																			
Lidars (include. KosaNet)				x		x	x		x	x		x	x	x				x	
Kosan				x			x		x	x			x	x				x	
Amami Ojima								x											
Ron Brown			x		x			x	o										
Twin Otter			x												x				
KingAir																x			
NASA P-3 (TRACE-P)	x	x																	
Frontal Systems						x													

Two LTIs

ACE-Asia was the first experiment to use Two Low-Turbulence Inlets to enable sampling of supermicron particles.

How Did the LTIs Modify the Ambient Size Distribution?

The **Total Aerosol Sampler** (middle) provided a **reference** measurement even for the largest particles.



NOAA R/V Ron Brown West of Japan

The Brown Collected Time-Series Data from the Surface

B. Huebert, ACE-Asia Data Workshop, Pasadena, 10/01

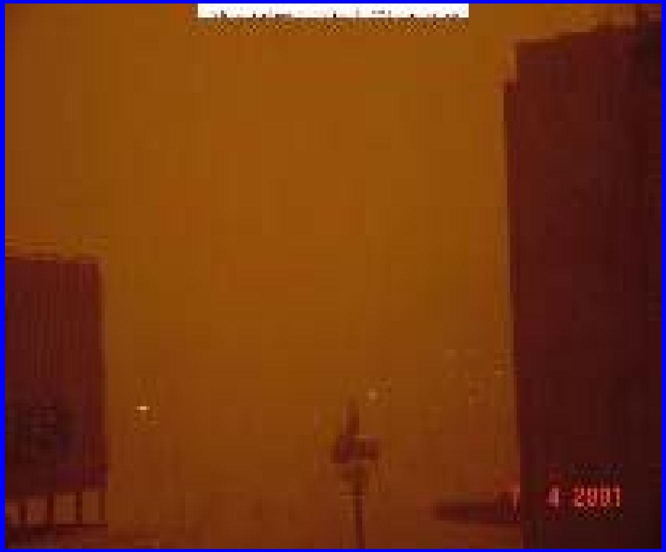
The C-130 flew patterns near the Kosan site repeatedly.

They had 2 Lidars and multiple in situ measurements.

The Twin Otter had Some Identical Instruments (Moudi) and Some Unique Ones (MS) to Compare with Other Platforms.

We Sampled Some Severe Dust Outbreaks From China
7-8 April Photos, 11-13 April flights

These photos are reduced-resolution versions of photos taken by Dr. Zev Levin while visiting Baicheng, Jilin Province, China (NE of Beijing) during the dust storm. The first two were taken on April 7th. The third was taken on April 8th. The two buildings seen in the foreground of the third image are also seen in the second



From P. Westphals web site:

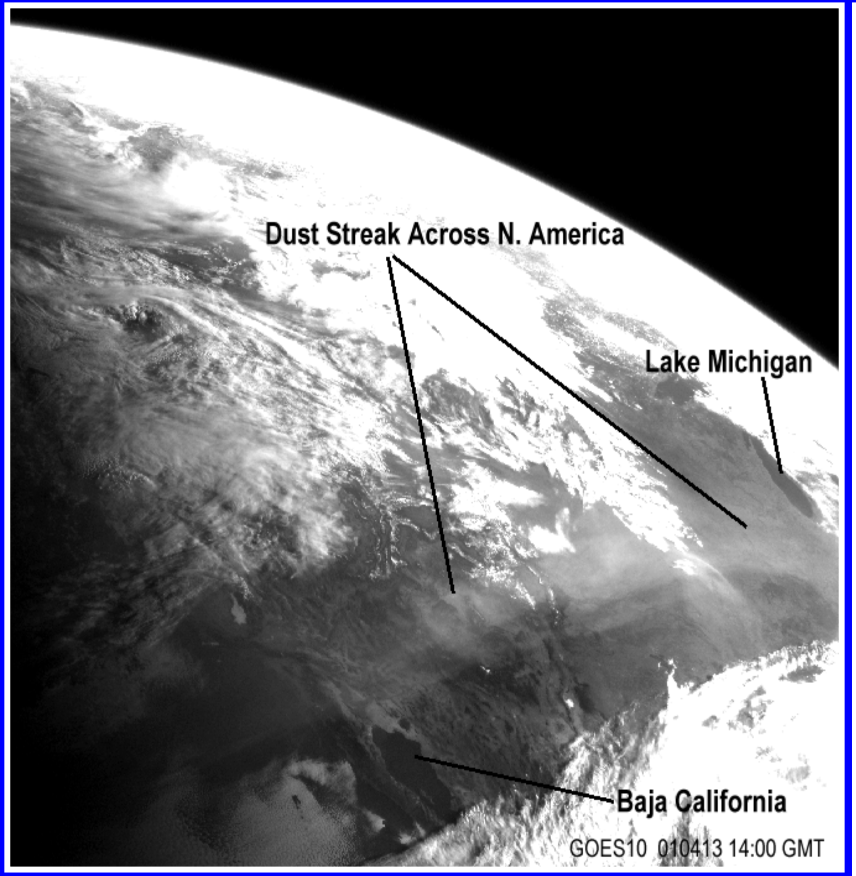
http://www.nrlmry.navy.mil/aerosol/Case_studies/20010413_epac/

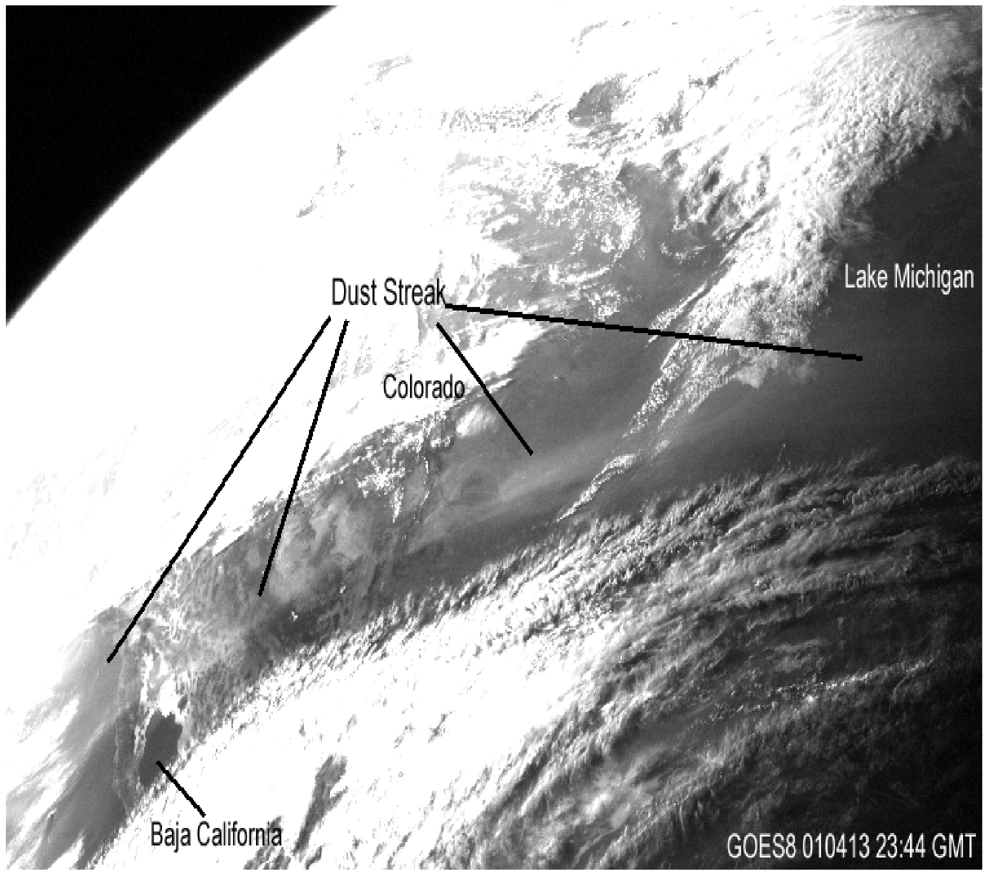
The dust cloud passed over the Midwest, over NE US and into the Atlantic.

***As reported by*:**

http://www.boston.com/dailyglobe2/110/metro/Massive_dust_cloud_to_travel_over_N_E_+.shtml

http://www.rockymountainnews.com/drmn/local/article/0,1299,DRMN_15_320482,00.html



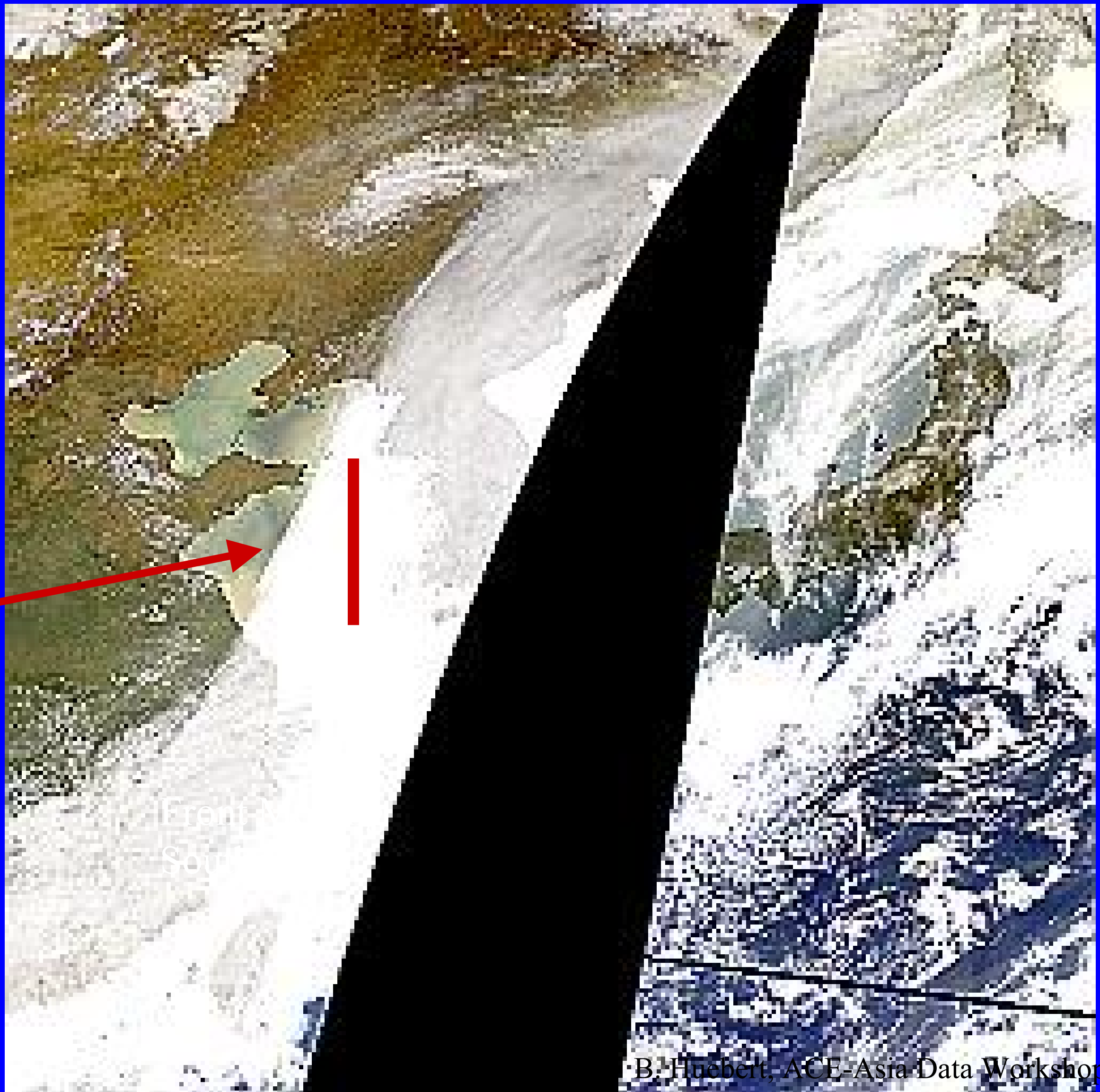


GOES8 (East) view of dust streak on the evening of Friday 13th

From: http://capita.wustl.edu/AsiaDust0104/reports/ThePerfectStorm.htm

11 April, 2001- The Perfect Dust Storm

SeaWiFS Image Showing Dust in Yellow Sea Behind Frontal Clouds



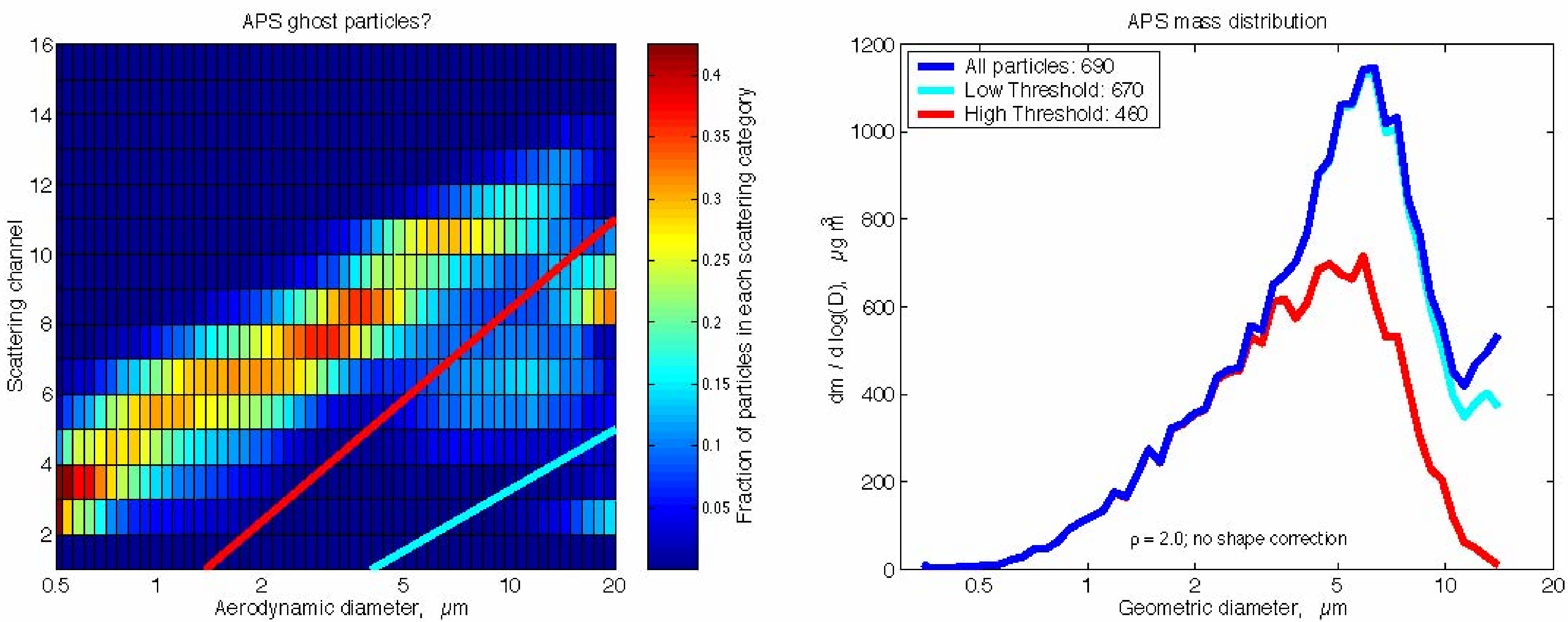
C-130 Track

Sampling Dust Behind Front

~1000 ug/m3

SeaWiFS image courtesy of NASA and Orbimage

Aerodynamic Particle Sizers Measured the Physical Size Distribution of Supermicron Particles



B. Huebert, ACE-Asia Data Workshop, Pasadena, 10/01

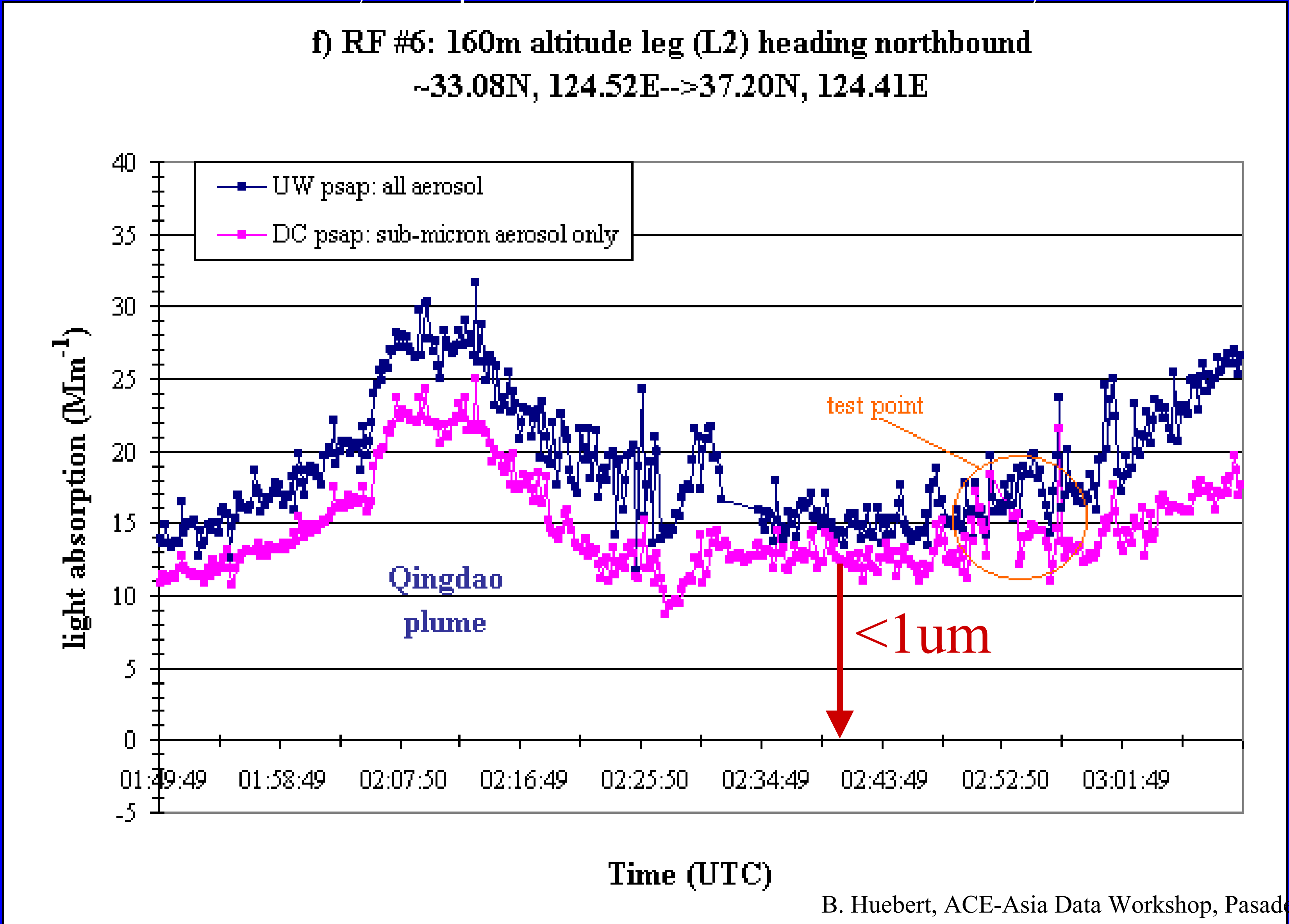
After Correction for Ghost Particles, the APS Suggests a Mass Peak Aerodynamic Diameter of About 5-6 um.

Will Inlet or Plumbing Effects Change that Conclusion?

What Size is the Carbon? (EC?)

Most light absorption was by small particles (soot)

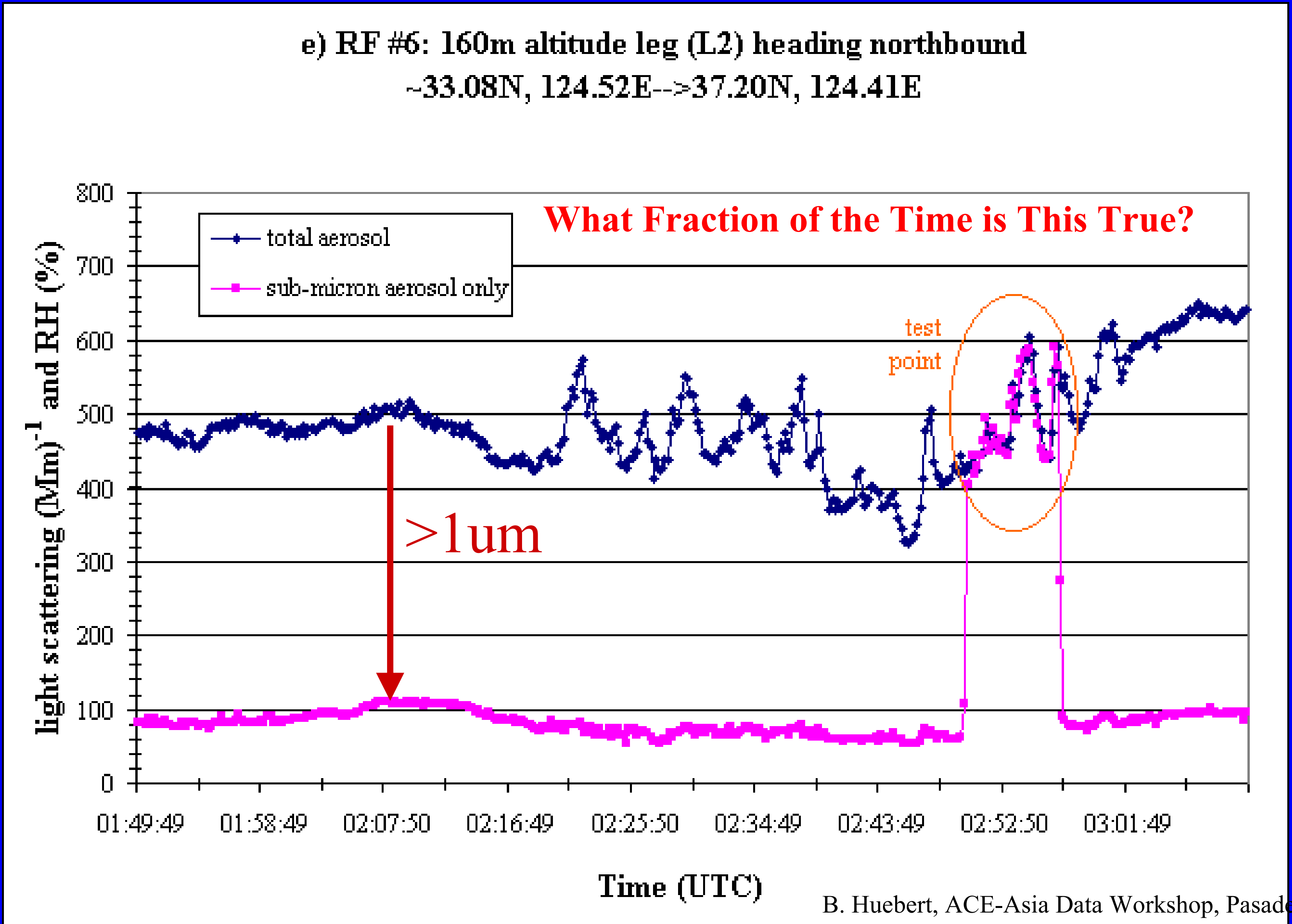
Yellow Sea, 11 April 2001 - Masonis and Anderson, UW



B. Huebert, ACE-Asia Data Workshop, Pasadena, 10/01

However, most light scattering was by big dust particles

Yellow Sea, 11 April 2001, Masonis and Anderson, UW



Deposits on Impactors

Raised dust deposits were clearly visible on this 1 um impactor on RF13. (Used by Tad Anderson and Sarah Masonis in front of a TSI nephelometer to measure sub-micron scattering.) We encountered 500 - 1000 um/m^3 of dust aloft.

Were Any Measurements Degraded by Dust?

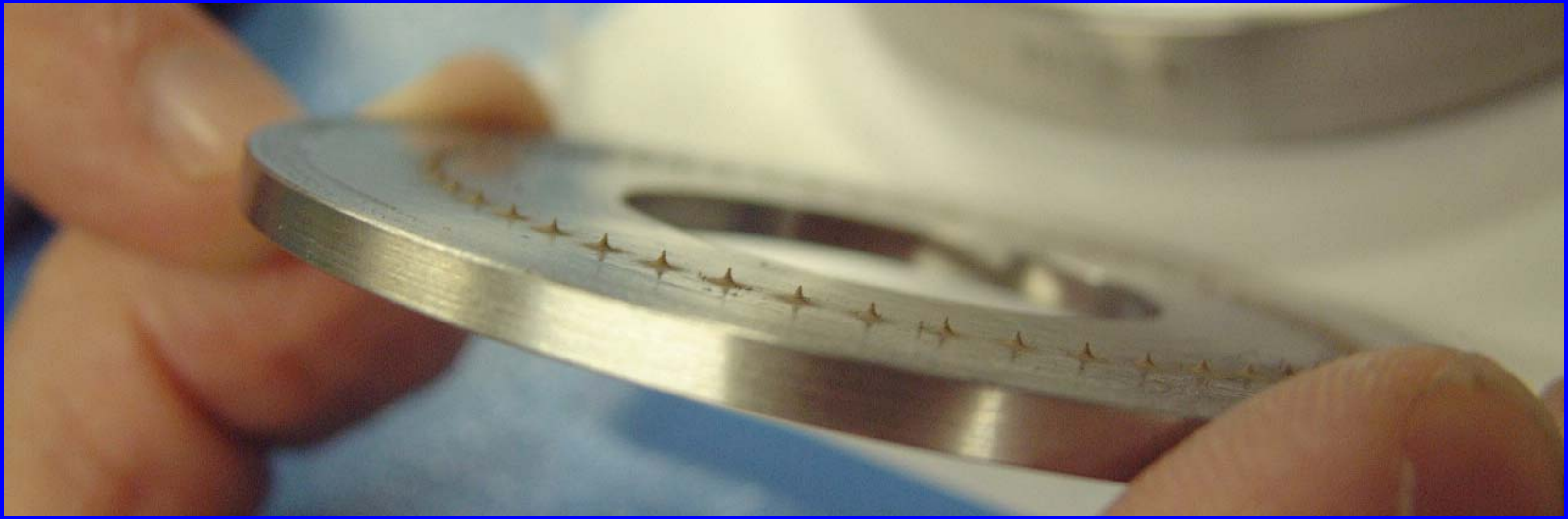
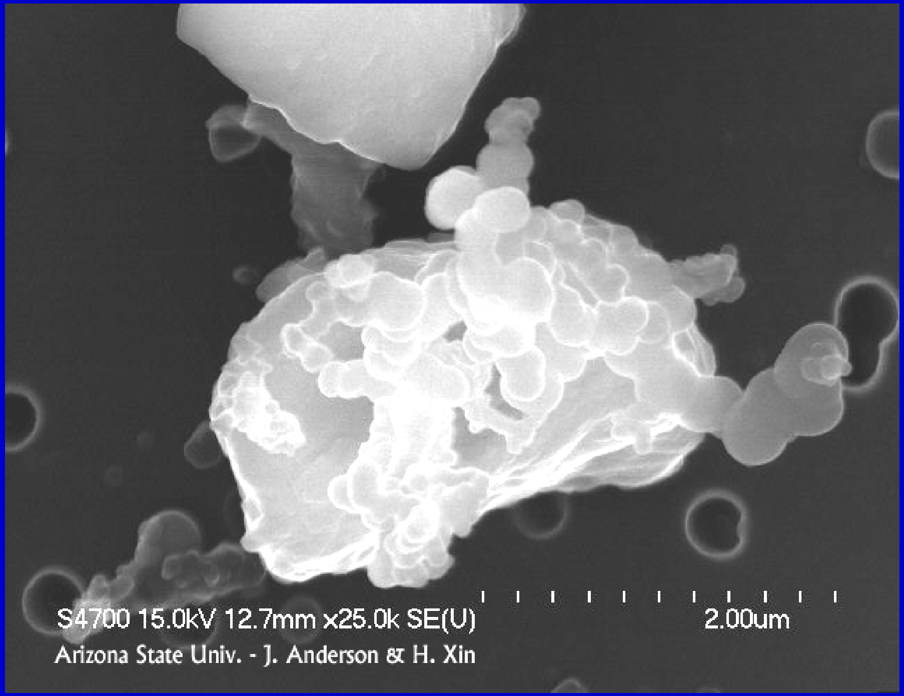
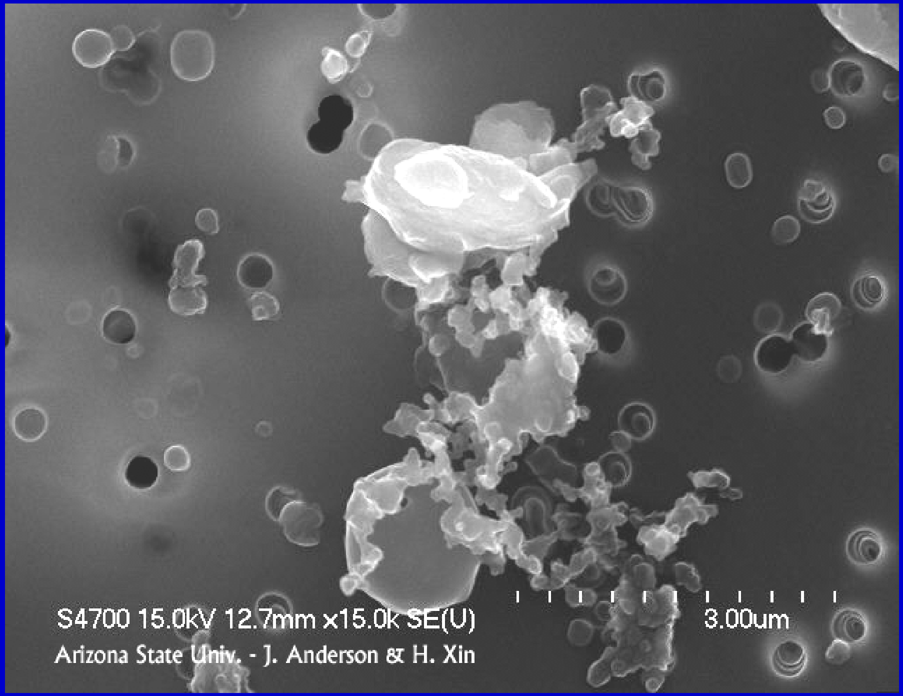


Photo courtesy of Tai Chen

These scanning electron micrographs by Jim Anderson show the complexity of the multicomponent aerosol.



Many different forms of soot stuck on a particle of quartz (SiO2).



Complex aggregate of soot, mineral particles (upper), and a non-soot carbonaceous particle.

To What Extent Were Aerosol Optical Properties Changed by Internal Mixing?

OC, ug/m3

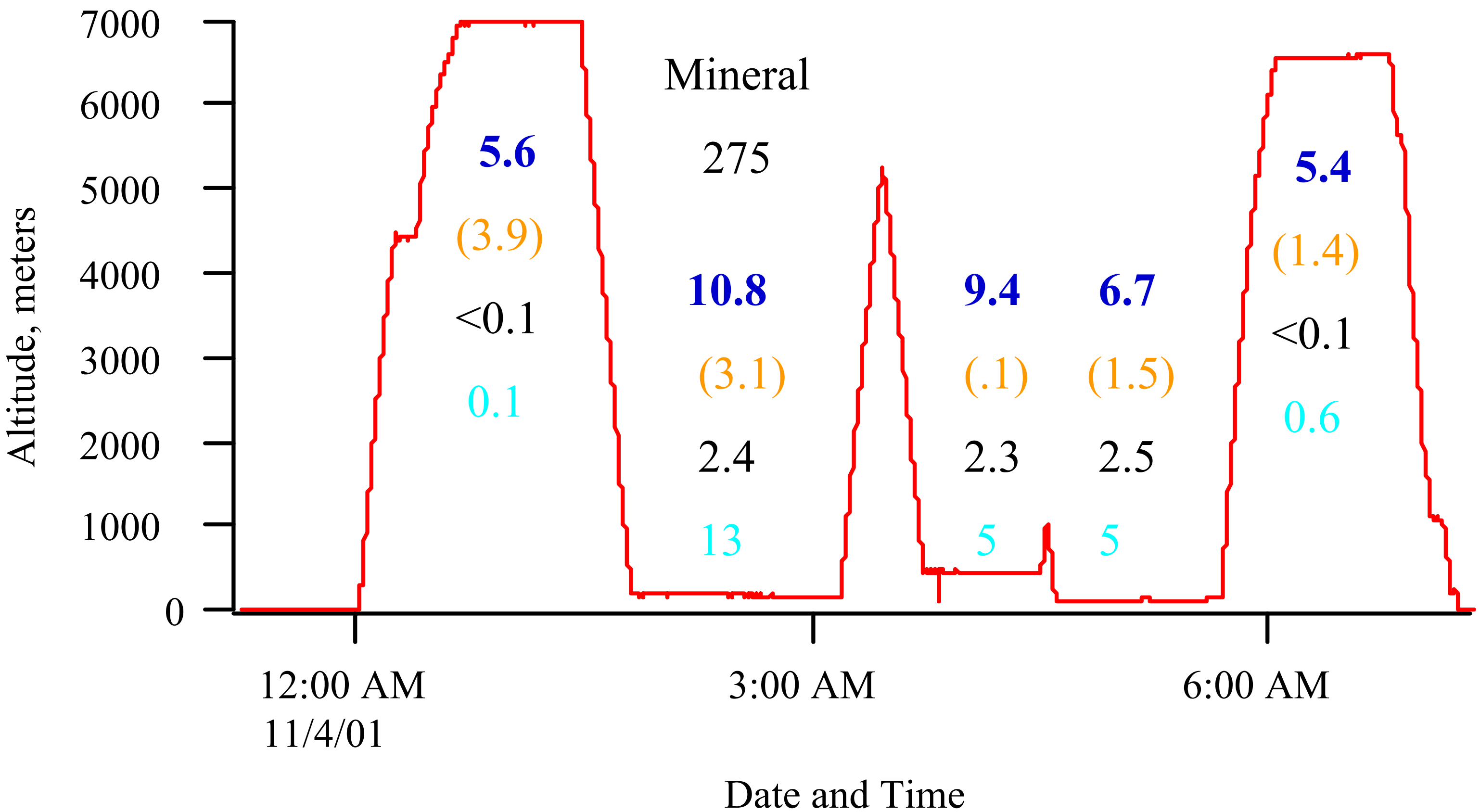
OC on CIG

EC, ug/m3

SO4, ug/m3

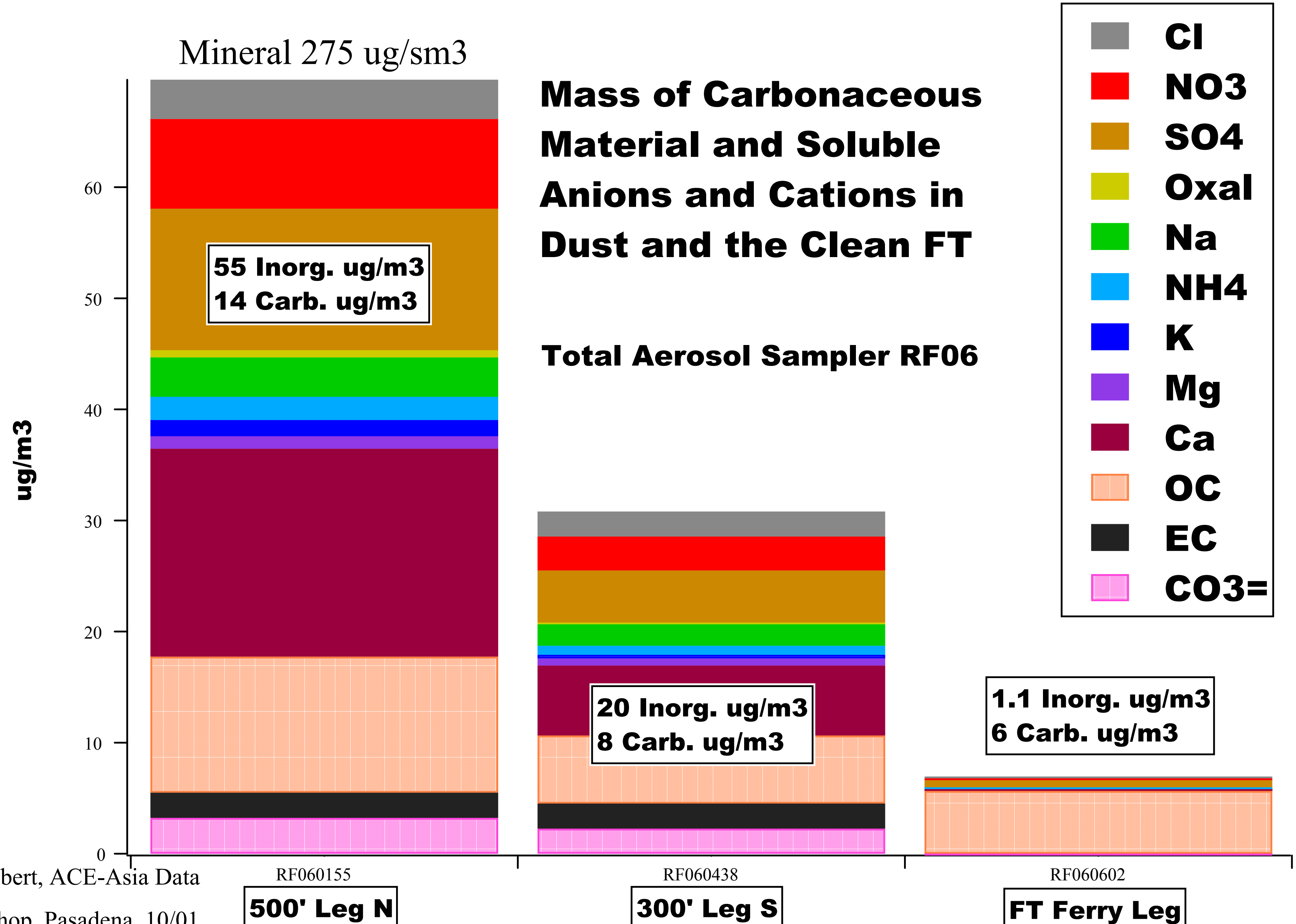
During the April 11 Dust flight, there was always more Aerosol Carbon than Sulfate!

Is That Often True?



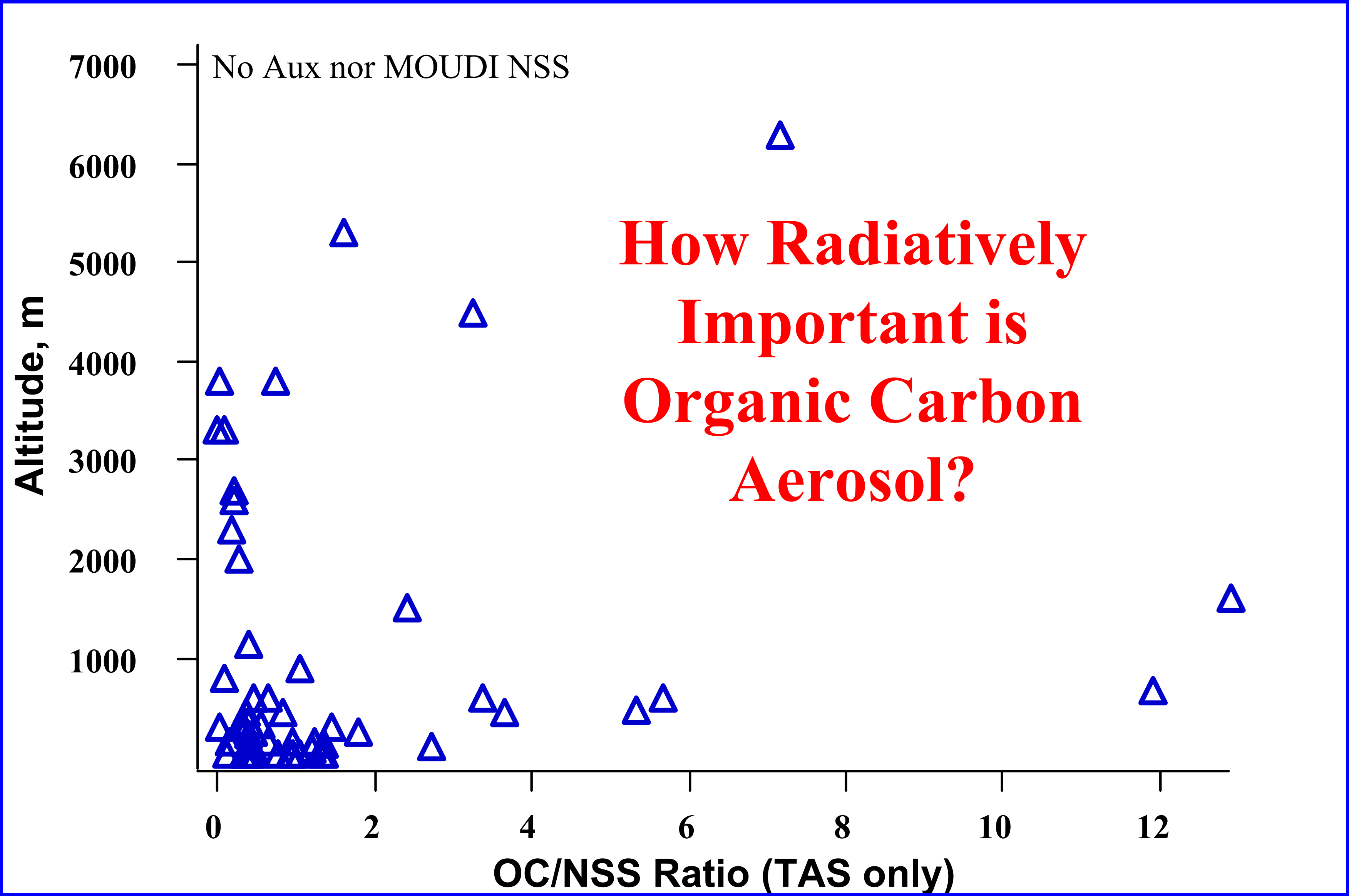
Huebert Group, UH

TAS identified SO4, NO3, and Ca as the major soluble ions in the dust storm. In the FT there was 5x more OC than anions plus cations.

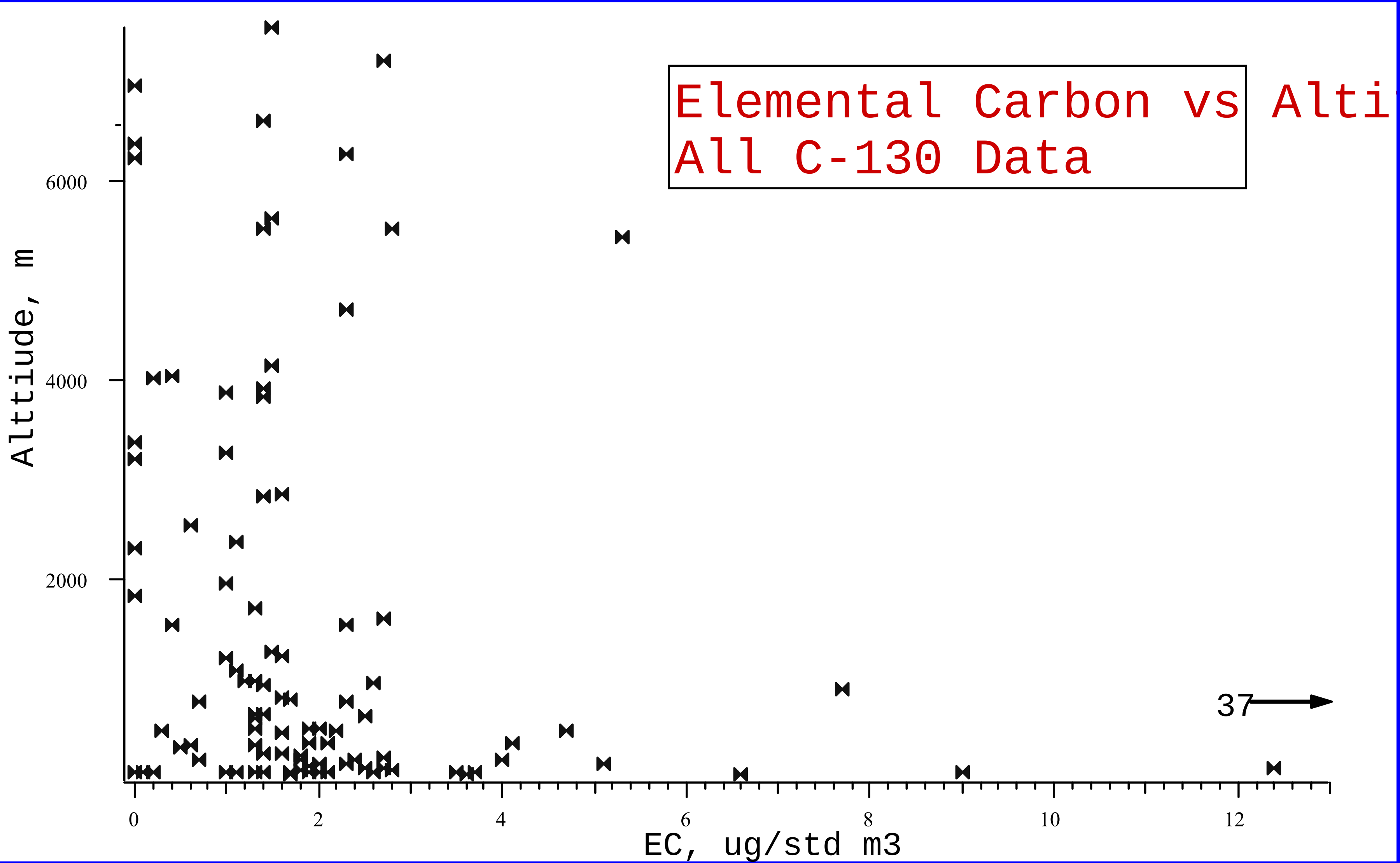


B. Huebert, ACE-Asia Data Workshop, Pasadena, 10/01

Organic C vs Sulfate Aerosols vs Altitude



While a Few Low-Level EC Values Were Elevated, Most Fell Between 0 and 3 ugC/std m^3, Regardless of Altitude



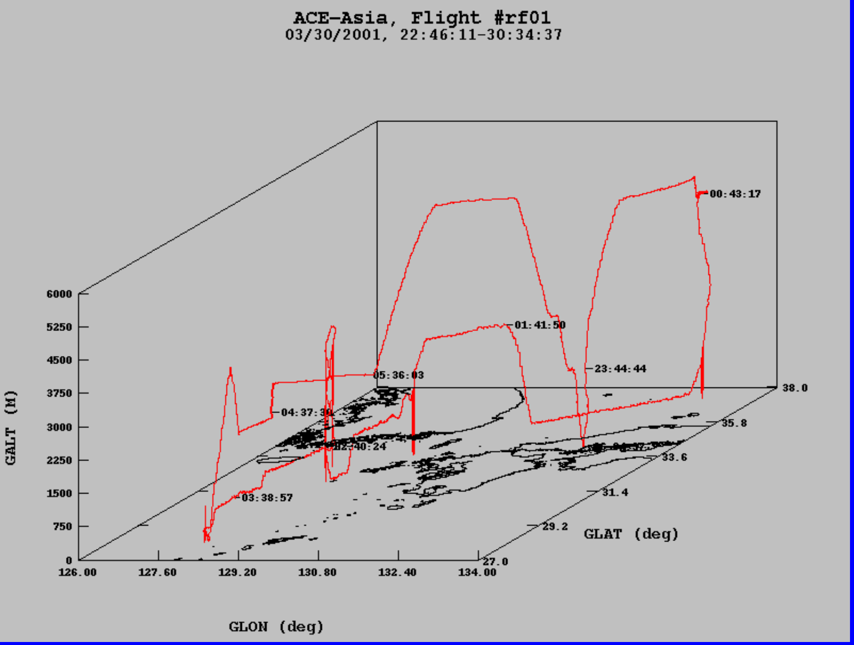
Interagency Cooperation:

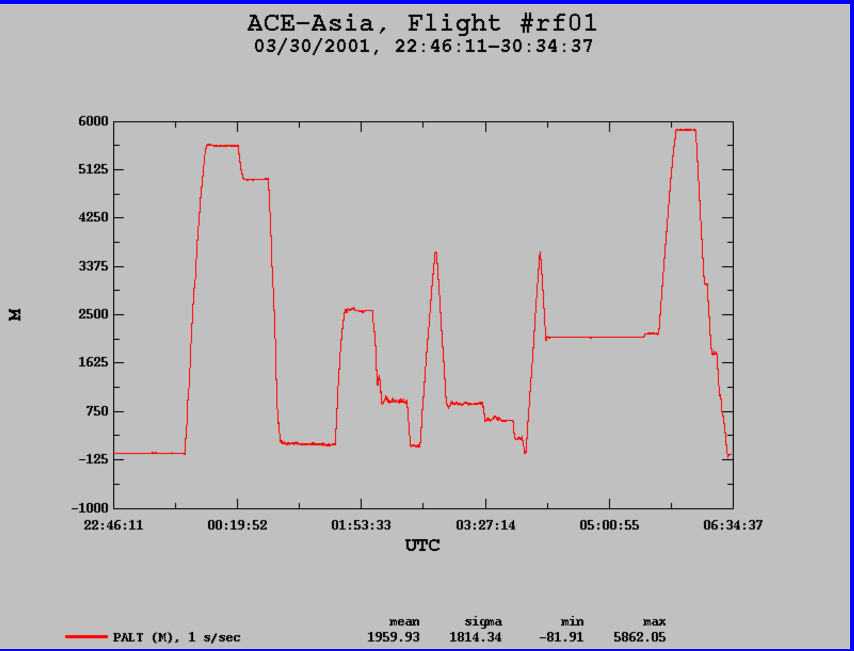
We flew two flights with the NASA P-3 in the TRACE-P program.

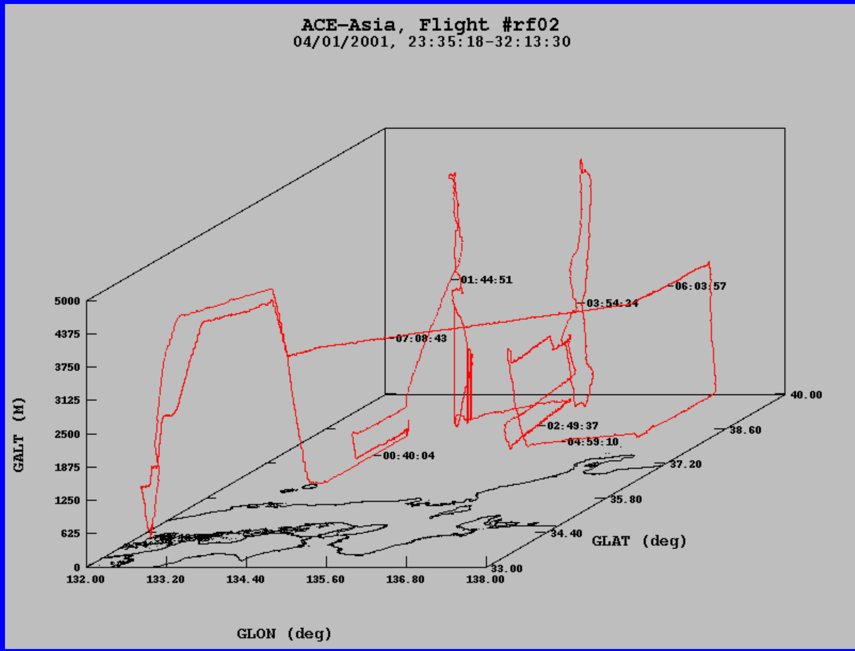
Any Photochemical Insights?

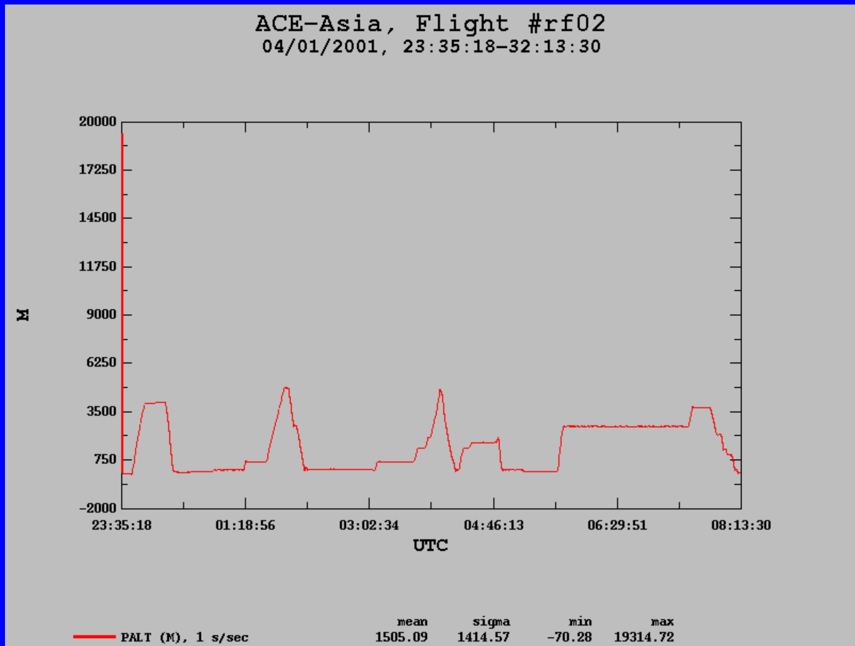
For many species, we can extend our mutual time-series is we can show that our measurements are comparable.

CO, O_3, CN, SO_2, Scattering, Aerosol Size, Anions & Cations, etc.


ACE-Asia, Flight #rf01
03/30/2001, 22:46:11-30:34:37
GALT (M)
6000
5250
4500
3750
3000
2250
1500
750
0
126.00
127.60
129.20
130.80
132.40
134.00
GLON (deg)
27.0
29.2
31.4
33.6
35.8
38.0
GLAT (deg)
00:43:17
01:41:50
23:44:44
05:36:03
04:37:30
02:40:24
03:38:57


ACE-Asia, Flight #rf01
03/30/2001, 22:46:11-30:34:37
M
6000
5125
4250
3375
2500
1625
750
-125
-1000
22:46:11
00:19:52
01:53:33
03:27:14
05:00:55
06:34:37
UTC
PALT (M), 1 s/sec
mean 1959.93
sigma 1814.34
min -81.91
max 5862.05


ACE-Asia, Flight #rf02
04/01/2001, 23:35:18-32:13:30
GALT (M)
5000
4375
3750
3125
2500
1875
1250
625
0
132.00
133.20
134.40
135.60
136.80
138.00
GLON (deg)
33.00
34.40
35.80
37.20
38.60
40.00
GLAT (deg)
01:44:51
03:54:34
06:03:57
07:08:43
02:49:37
04:59:10
00:40:04


ACE-Asia, Flight #rf02
04/01/2001, 23:35:18-32:13:30
M
20000
17250
14500
11750
9000
6250
3500
750
-2000
23:35:18
01:18:56
03:02:34
04:46:13
06:29:51
08:13:30
UTC
PALT (M), 1 s/sec
mean 1505.09
sigma 1414.57
min -70.28
max 19314.72

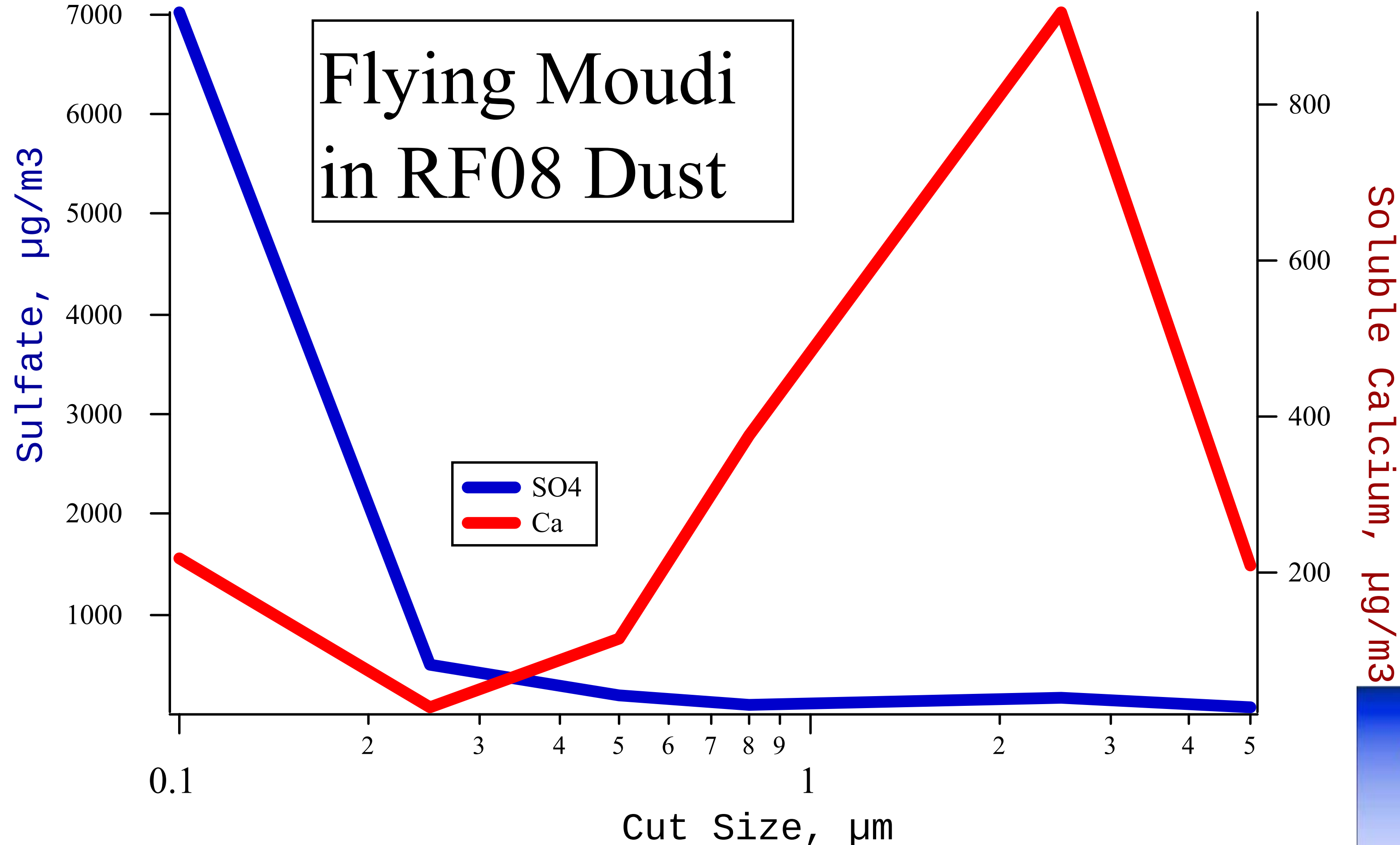
Possible SO2 Oxidation Mechanisms

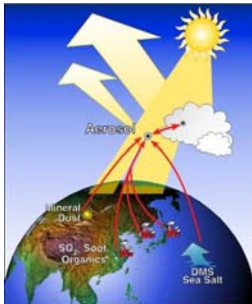
1. $SO_2 + OH \rightarrow H_2SO_4$ (Homogeneous, gas phase)
2. $SO_2 + H_2O_2 \rightarrow H_2SO_4$ (In cloud water)
3. $SO_2 + O_3 \rightarrow H_2SO_4$ (on sea salt)
4. $SO_2 + CaCO_3 \rightarrow CaSO_4$ (on alkaline dust particles)
5. SO2 → Dry Deposition to the Surface (Loss)

Each Mechanism Would Create a Different Size of Sulfate Particles and Thus Have a Different Impact on Light

The MOUDI Shows that Calcium (dust) and Sulfate (pollution) are in Different Size Modes

Correct Unit: ng/m3 per Stage

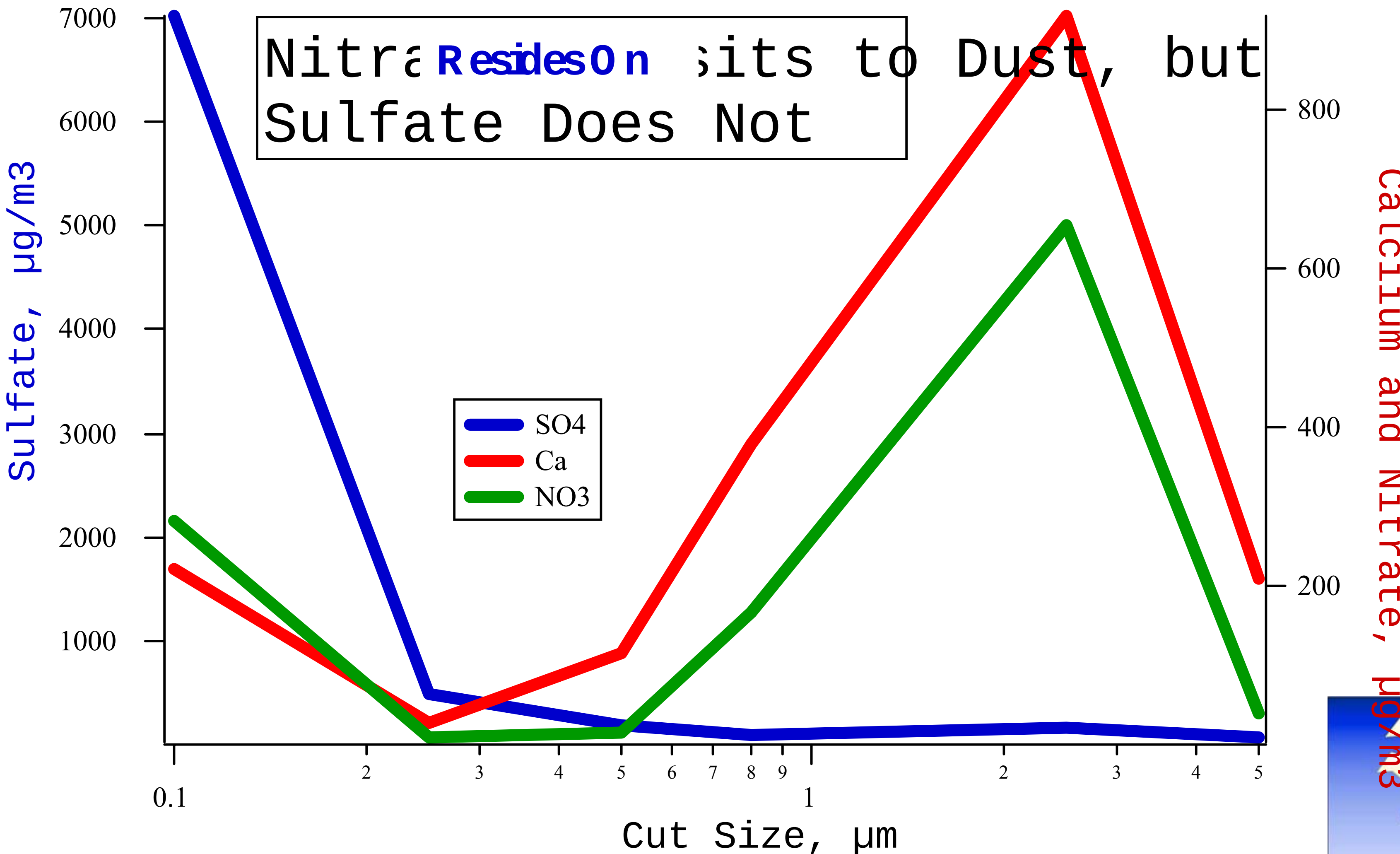




B. Huebert, ACE-Asia Data Workshop, Pasadena, 10/01

Would Wet Dust Take Up More SO_2?

Correct Unit: ng/m3 per Stage

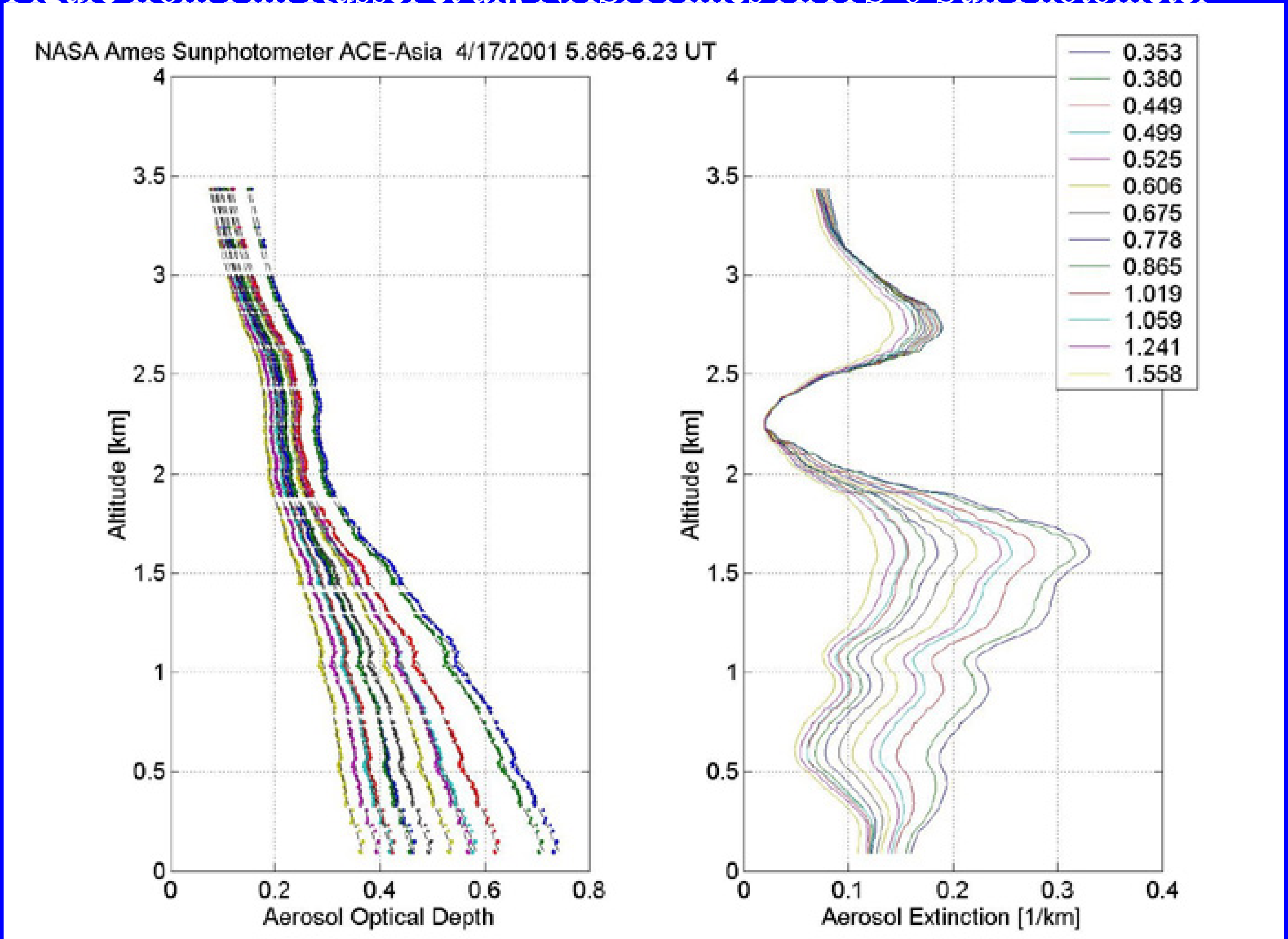


B. Huebert, ACE-Asia Data Workshop, Pasadena, 10/01

The Extinction by Large Dust Particles is Far Less Wavelength Dependent That That of Submicron Pollution Aerosols.

How Do these Aerosols Modify Actinic Fluxes?

Figure from Phil Russel et al., NASA Ames AATS-6 Sun Photometer



B. Huebert, ACE-Asia Data Workshop, Pasadena, 10/01

Commercial Slide Film A

QuickTime™ and a
Photo CD Decompressor
are needed to use this picture

Commercial Slide Film B

QuickTime™ and a
Photo CD Decompressor
are needed to use this picture

One can derive totally different conclusions due to slight differences in calibration

ACE-Asia and TRACE-P Have a Lot of Complimentary Data.

How Can We Get The Most Out of Our Related Data-Sets?